RESEARCH ARTICLE

Experimental Investigation on Influence of Solvents on Extracts from *Carica Papaya* for Potential use in Textile Coloration using Infrared Spectroscopy

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ABSTRACT: Extraction and characterization of *Carica papaya* were studied using four solvents namely Sodium hydroxide (NaOH), Hydrochloride acid (HCl) Ethanol (C_2H_5OH) and distilled water which was the control solvent. The solvent extracts water(control), Sodium hydroxide (P_{NaOH}), Hydrochloride acid (P_{HCl}), and Ethanol (P_{ETOH}) were characterized each using Fourier Transform Infrared Spectroscopy (FT-IR) to determine the effect of solvents on the functional groups respectively. The results of FT-IR spectroscopy showed gradual changes as pectin, lignin, Hemicelluloses, oil, and waxes were removed with respect to solvent used in the chemical treatment. Intensity of stretch on active site of carbonyl-H, OH, C=H, and C=O on *C.papaya* chain showed that the number of hydroxyl groups on the dye surface decreased with the use of acid as less phenolic component was seen in the extract. Sodium hydroxide (NaOH) led to more yield of the flavonoids and phenolic components by increasing the yield of OH and other functional groups on the extract chemical chain, ethanol yielded more of OH to the chain of the extract alongside creating more anti-symmetric stretch caused by increased molecules of C=C due to more H+ molecule introduced into the *Carica papaya* molecular chain. From this study, it can be seen that solvents of Sodium hydroxide (NaOH) and Ethanol (C_2H_5OH) enhanced the yield of phenolic components in the extract, unlike Hydrochloride acid (HCl) which depleted it. Ethanol and Hydrochloric acid yielded more anti-symmetric C=C, and C-Cl stretch on the backbone chain of the extract of *Carica papaya.*

KEYWORDS: Experimental, Characterization, *Carica papaya*, extraction, solvent, Spetroscopy, Phenolic component.

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INTRODUCTION

Carica papaya, is a herbaceous succulent plant, belonging to the *Caricaceae* family. Believed to originate from *Carica* native of Mexico, and Central America but is widely cultivated in other tropical regions of the world including Nigeria, for its edible melon-like fruit [1, 2, 3]. Pawpaw is usually grown from its seed, its development is rapid, with fruit being produced before the end of the first year and under favorable conditions the plant may live five years or more. In some regions its orchards are replanted after 8 to 10 years, while in some areas like in Nigeria is allowed to produce satisfactorily for 20 to 25 years or more, depending upon their resistance to diseases, pests, and winter damage. *C. papaya* also referred to as "Pawpaw" is known with different names such as okwulu bekee by the Igbo, Ibepe by the Yoruba and kawuse by the Hausa tribes of Nigeria [4-11]. *C. papaya* has seen its different parts been used for the treatment of different human and veterinary diseases in various parts of the world [2]. In Asia, the fruit has found its traditional use as an antiseptic for wound dressing, and cure for dyspepsia [2, 3]. In Africa however, it has found its use in the treatment of pile, ringworm, cancerous growth and venereal diseases [12,3]. The extracts of its fruit and seed have been reported to possess bactericidal attributes having good efficacy against Staphylococcus aureus, Bacillus cereus, Escherischia coli, Pseudomonas aeruginosa, and Shigella flexneri [7]. C. papaya pulverized seeds have been reported to possess antiparasitic attributes against Entamoeba histolytica and Dirofilaria immitis infections [8], a sedative and muscle relaxant [9], having purgative properties [10, 12], acts as a reversible anti-fertility agent

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[13] and used as anti-dengue activity[14]. The *C.papaya* is slightly sweet, with musky tang, which is more pronounced in some varieties and in some climates than in others. In many countries, it serves as breakfast fruit, appetizer, used in salads, pies, juices, and confections. The unripe fruit can be cooked like squash.

The physical description of *C. papaya* shows a tree with a palm like trunk, up to 8 metres (26 feet) tall; not as woody as the designation generally implies.

The plant has deeply lobed leaves of about 2 feet (60cm) across, borne on hollow petioles (leaf stalks) 60 cm long. Normally, the species is dioeciously; male and female flowers being produced on separate plants but hermaphroditic forms are known and numerous irregularities in the distribution of the sexes are common. Male flowers are borne in clusters on stalks 90 cm long; the flowers are funnel-shaped, about 2.5 mm (0.1 inch) long and whitish with 10 stamens in the throat. The female flowers are considerably larger on very short stalks and often solitary in the leaf axils; they have five fleshy petals that are united toward the base and a large cylindrical or globose superior ovary that is crowned by five fan-shaped sessile stigmas.

Carica papaya fruit and leave extractions are typically done using conventional techniques which involve a mechanical or solvent extraction method. Solvent methods have been employed where crude papaya oil is refined by treating it with caustic soda to neutralize free fatty acids and make other changes [15]. Studies have been reported on the boiling and [16, 17], soxhlex methods of extraction [18] which are conventional techniques. Husnul Hanani Soib et al., [19] used ethanol and partitioned chloroform and distilled water to extract *Carica papaya* for phytochemical analysis. Recently the use of ultrasonic assisted and microwave extraction mechanism have been reported in the extraction of *Carica papaya* [20, 21].

Carica papaya have found its applications in several areas such as in fashion industries for cream and soap making and for its health benefits as a remedy and orthodox drug for some ailment [22]. Many plants have found their potential use in textile coloration [23] , *Carica papaya* possess such ability to be used as dye and as an indicator [24] due to the presence of polyphenols, phenolics and flavonoids composition properties present in *Carica papaya* leaves (*Carica papaya Linn.*) [25]. *Carica papaya* has also found its use as photo sensitizers used in the fabrication of ZnO-based dye-sensitized solar cells (DSSCs) [26, 27, 28].

Meanwhile, sufficient information is not available so far on characterization of *Carica papaya* extract using the solvents. The aim of this paper is to characterize dye extract from *Carica papaya* using different solvents namely distilled water, dilute Sodium hydroxide (NaOH), Hydrogen chloride acid (HCl) and Ethanol (C_2H_5OH).

MATERIALS AND METHODS

Materials

The Carica papaya fruit used was purchased from Relief Market Owerri, Imo state. The analytical reagents (distilled water (H_2O), sodium hydrogen (NaOH), Hydrogen chloride (HCl), Ethanol (C_2H_5OH)), cylinder, bottom flask, conical flasks, spatula, pipettes, beakers, funnel, filter paper, sample bottles, test tube, syringe, weighing cylinder, and equipment (water bath, weighing balance, grater, grinder, spectrophotometer, Pycnometer, Fourier-transform infrared spectroscopy) were obtained from Soil Science Laboratory, School of Agricultural Technology, Federal University of Technology Owerri.

Preparation of Carica Papaya Extract

Fresh Carica papaya fruits were thoroughly washed, peeled, dried and ground. The ground *Carica papaya* was weighed out (1.12kg) ready for extraction(s).

i. Extraction of Carica papaya using Distilled water (Aqueous extract P_{H2O})

Distilled water (H_2O) was employed in the extractions of dye from *Carica papaya* in a material to liquor ratio of 1:2 inside a 1000ml beaker and stood for 24hours using conventional extraction method for the extraction. After extraction the *Carica papaya* skin sample was sieved out to obtain the *Carica papaya* dye extract.

ii. Extraction of Carica papaya using Sodium Hydroxide (Alkaline Medium P_{NaOH})

Dilute Sodium hydroxide (NaOH) was employed in the extractions of dye from *Carica papaya* in a material to liquor ratio of 1:2 inside a 1000 ml beaker and stood for 24hours using conventional extraction method for the extraction. After extraction the *Carica papaya* skin sample was sieved out to obtain the *Carica papaya* dye extract.

iii. Extraction of Carica papaya using Hydrogen chloride (Acidic Medium P_{HCl})

Hydrogen chloride (HCl) was employed in the extractions of dye from *Carica papaya* in a material to liquor ratio of 1:2 inside a 1000ml beaker and stood for 24 hours using conventional extraction method for the extraction. After extraction the *Carica papaya* skin sample was sieved out to obtain the *Carica papaya* dye extract.

iv. Extraction of Carica papaya using Ethanol (C_2H_5OH P_{ETOH})

Ethanol (C_2H_5OH) was employed in the extractions of dye from *Carica papaya* in a material to liquor ratio of 1:2 inside a 1000ml beaker and stood for 24hours using conventional extraction method for the extraction. After extraction the *Carica papaya* skin sample was sieved out to obtain the *Carica papaya* dye extract.

Characterization of the Different Carica papaya Dye extracts

The dye extracts obtained from water, alkaline, acidic, ethanol media were characterized. The techniques employed for the characterization of the dye extracts were done using spectrophotometer and Fourier-transform infrared spectroscopy (FTIR-8400S). Both techniques were carried out at Springboard Research Laboratory Awka, and each sample for characterization with respect to its medium of extraction is denoted as P_{NaOH}, P_{HCL} and P_{ETOH} .The analyses of the functional groups existing in the samples were investigated using FT-IR.

RESULT AND DISCUSSION

Figure 1-4 represent the Plot of Fourier Transform Infrared Spectroscopy (FTIR) Analysis of the *C.papaya* Extract Using Different Solvents.

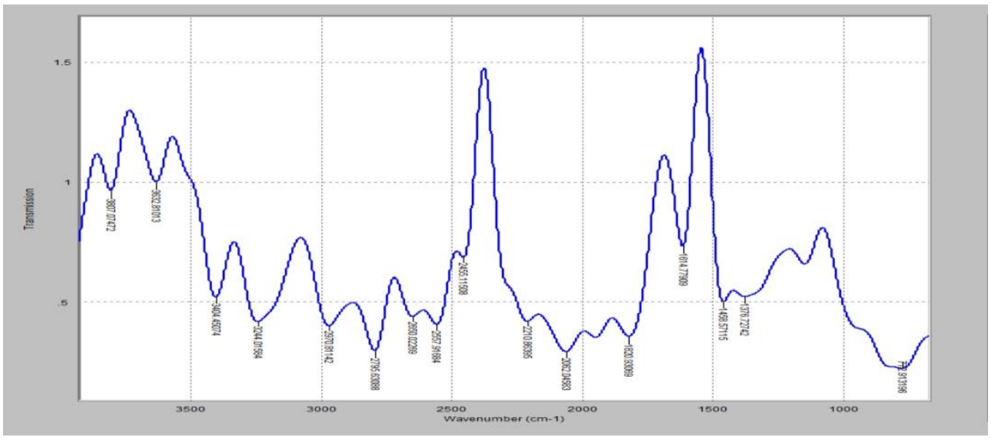

Figure 1: FT-IR Analysis of Aqueous extract of *Carica papaya* (control sample)

Figure 1 represents the FT-IR analysis of aqueous extraction of *Carica papaya.* It can be seen from the figure, visible halogenous compound vibration was observed on its stretched chain at 723cm^{-1} with an anti-symmetric stretch close to the C=C conjugated bond with it lessen at the reactive amine site at 1615cm^{-1}. Beyond this was no anti-symmetric stretch which existed on the chain that contained a very active function group of a cyclic ester and carboxylic acid. At the peak ranges of 2455cm^{-1} – 2971cm^{-1} the anti-symmetric stretching occurred where Nitrile, methylene and thiocyanate active sites were seen. The transfer of molecules from the solvent to the solute yielded OH+ to the extract give the large presence of OH+ functional group that was observed at 3244cm^{-1} – 3807cm^{-1} on the stretch chain *Carica papaya*. This depicts that aqueous solvent affected the carotenoid pigments; polyene content of the fruit due to its polar nature in the fruit chain, there was exchange of H+ in the chain strengthening the nitrile bonds present. This makes the extract suiting as an azo dye effective for use in textile coloration [29-31]. This is supported by Oguzie et al. [23] in their studied reviewed the potential of *Peristophe Roxburghiana* plant and its application in textiles they reported that the anthocyanin which is a phenolic component was not affect by the solvent.

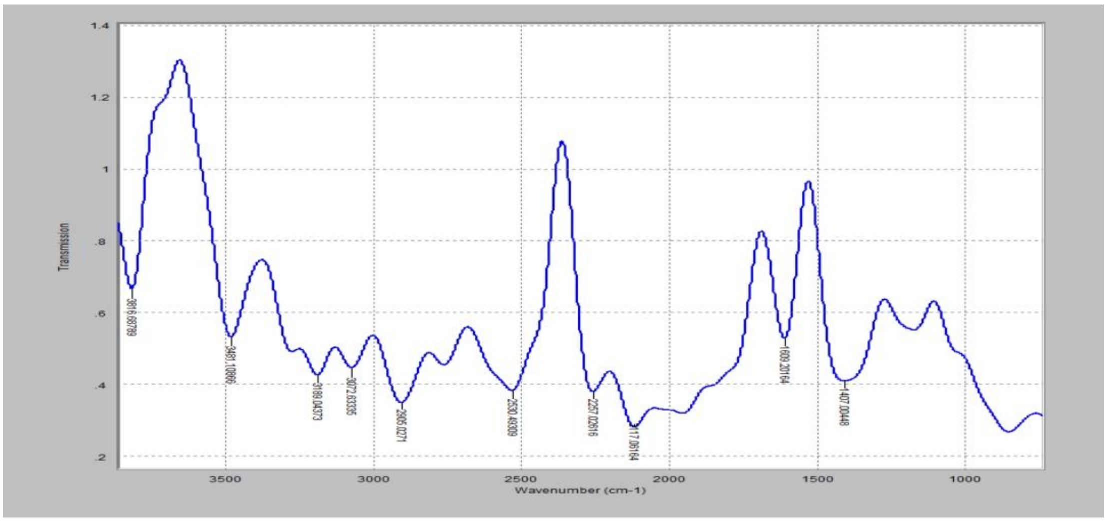

Figure 2: FT-IR Analysis of Alkaline extract of *Carica papaya*

FT-IR of Alkaline extract of *Carica papaya* is shown in Figure 2 the extraction of *Carica papaya* with an alkaline showed that from the peak range of 1407 cm^{-1} – 2905cm^{-1} there was a presence of a C=C conjugate bond which vibrate anti-symmetrically stretch *Carica papaya* chain structure down to the amine N=N. this solvent enhanced the amine sites in the chain. Carboxylic and carbonyl active functional groups were observed in the chain backbone at 3189 cm-1 there was visible presence of OH which were optimized by the solvent yielding more phenolic and flavonoids functional compounds in the molecular chain of *Carica papaya* making the dye extract rich in dye stuff. This is in agreement with Blackwell et al., [31] studied the use of alkaline in extraction of phenolic compounds from intact sorghum kernels and reported that the solvent gave the extract a quality yield. Nnorom and Onuegbu [32] in their study of the Authentication of *Rothmannia whitfieldii* dye extract with FT-IR Spectroscopy reported that the use of alkaline increased solubility of the dye component in the plant material due to the presence of OH group present in phenols.

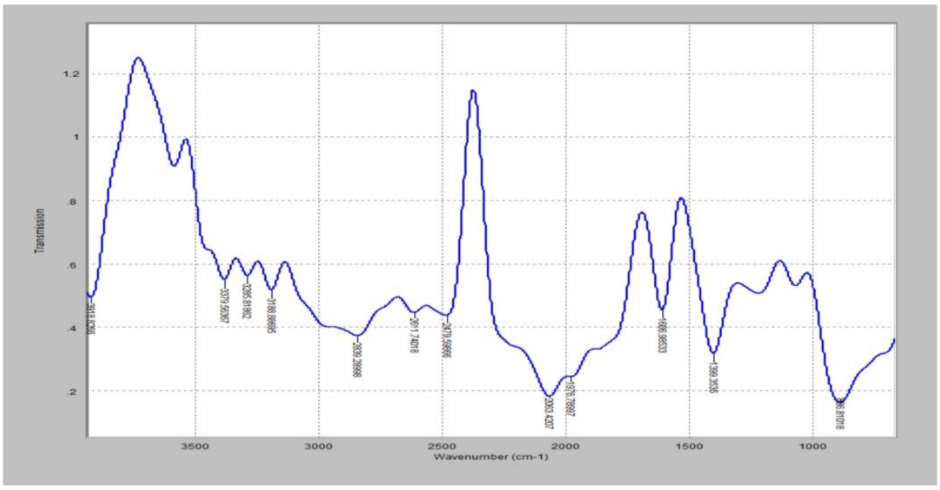

Figure 3: FT-IR Analysis of Ethanol extract of *Carica papaya*

Figure 3 shows the FT-IR of ethanol extract of *Carica papaya* caused the structure of the fruit plant to linearly stretch towards the C-Cl conjugate bond with a further vibration on the conjugate $H_2C=CH$ bond producing anti-symmetric stretching. From 1615cm^{-1}-2455cm^{-1} the presence of amine cyclic ester, carboxylic acid and nitrile active functional sites were observed. This solvent caused anti-symmetric stretch at 3244cm^{-1} enhancing the OH bond and other polar sites in the structural chain. There was an increased anti-symmetric movement of *Carica papaya chain* due to more introduction of H+ molecule on the conjugate C=C sites. The solvent optimized active sites containing the phenolic compounds. This was in conformity with Bushra Sultana et al., [33] who reported on the high yield of phenolics using ethanol solvent.

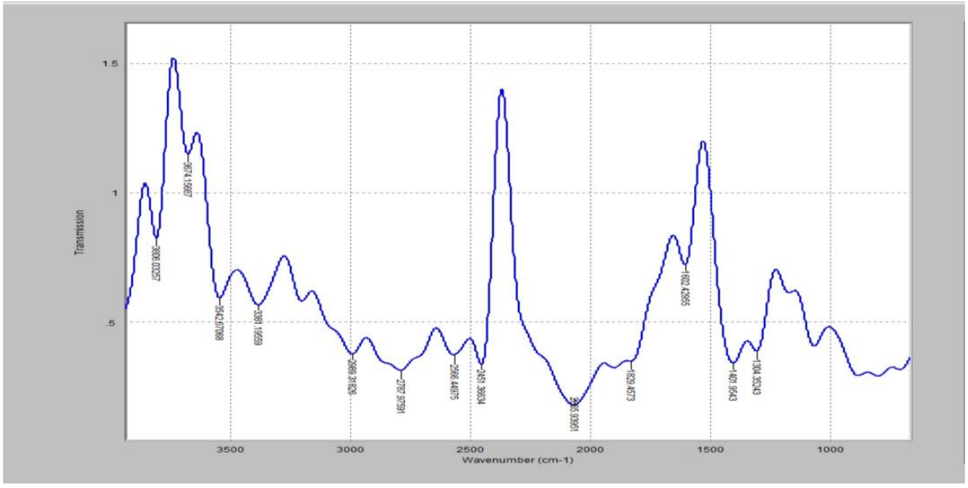

Figure 4: FT-IR Analysis of Acid extract of *Carica papaya*

Characterization of *Carica papaya* extract from acid medium is shown in Figure 4. It was seen that the hydrogen chloride solvent in the extraction of *Carica papaya* led to the structure of the fruit to linearly stretch extensively forming an anti-symmetric C-CL bond with a further stretching observed at the amine backbone at peak 1602cm^{-1}. From 1829cm^{-1}-2057cm^{-1} showed the active ester functional group and the presence of more active carboxylic acid and nitrile sites with reduced anti-symmetric stretch at 2567cm^{-1}. The use of HCl solvent led to the formation of a methylene stretch at 2788cm^{-1}. The use of acid solvent caused the creation of more polar covalent sites especially with the conjugate active sites of C=C. C. papaya dye extract qualifies to be referred to as an azoic dye suitable for dyeing natural fibers, food and drug colorant and can be further utilized as an indicator in acid-base titration.

CONCLUSION

The use of solvent in extraction had notable effect on the *Carica papaya* structural chain molecule. The extracts are azo dye and have potential to be applied in textile coloration. But to employ *Carica papaya* dye extract for textile coloration, the choice of fabric to color will determine the solvent to use in the extraction of the dye. Acid solvent may be suiting to use if wool is to be coloured. But the best solvent for extracting dye from *Carica papaya* suiting for a wider range of application will be Ethanol to alkaline solvents to enhance the amine sites dominant in azoic dye compounds. *Carica papaya* extract can be employed as a dye-sensitizer solar cell.

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